We Are All In This Together: Building a Network of Makerspaces in California Community Colleges

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INTRODUCTION

As outlined in ISAM 2016 paper #47, the CCC Maker Initiative is creating a network of California Community Colleges focused on producing creative, skilled, innovation-ready graduates. California's 2.1 million full and part-time community college students comprise the largest system of higher education in the United States. Sixty-seven percent of community college students are people of diverse ethnic backgrounds and roughly 53 percent are female [1]. As part of the "Doing What MATTERS for Jobs and the Economy" initiative and the Strong Workforce Taskforce recommendations to prepare students for high-value jobs in regions throughout the state, the California Community College Chancellor's Office (CCCCO) invested $17,000,000 to grow a statewide network of community college-based STEM/STEAM-focused makerspaces. This paper describes the 2016-2017 Start-Up process with 34 colleges (30 percent of 113 total colleges), the project's successes and identified challenges as 24 colleges implement their plans.

BACKGROUND

The CCC Maker initiative is a three-year statewide action strategy to prepare students for the innovation economy through the integration of makerspaces into academic environments. In the first year of the project (2016-2017):

- A core implementation team was assembled, including a project manager, technical assistance provider, organization development/strategic management leader, communications director, and grant accountant. A culture of trust, respect, open communication and accountability facilitated the implementation of project goals and supported a high performing startup process.

- A statewide advisory committee consisting of state and local leaders from the Maker Movement, the business community, and community colleges was convened to guide project design and implementation. Critical and ongoing conversations with advisors allowed the project to stretch beyond the comfort of structured and time-delineated education delivery models. Advisors participated in the review and selection of the Technical Assistance Provider and Implementation Grant awardees.

- A guided design thinking process was developed and delivered to a cohort of 34 colleges. With a theme of "We're All in This Together" and an expectation of collaboration, resource sharing and open source, colleges participated in a six-month self-directed lean launch process to produce customized, authentic, student centered implementation plans. Emphasis on makerspace community formation [Fig 1] enabled teams to see beyond the physical makerspace to an inclusive, interdisciplinary culture and ecosystem. The project team message fostered community and a safe place for risk, failure and iteration consistent with the maker movement.

- Specialized service providers supported the incorporation of making and entrepreneurship into curriculum, mapping stakeholder and partner ecosystems, developing skills badges and micro-credentials, preparing students with 21st century skills and work-based learning, and leveraging universities and research institutions.

- Communication structures and products were implemented to reduce barriers and increase information access. This included 14 recorded webinars, 16 electronic newsletters, 12 regional Meet-Ups, 130 one-on-one technical assistance sessions, 15 college site visits, and the website (cccmaker.com) and social media.

- Leveraged resources and a $40,000 Seed Grant were provided to support college work. Resources included an invitation to join Stanford Innovation Fellows, attend the Maker Education convening in San Francisco, present at the CCC Maker culminating celebration at College of San Mateo on May 19, and participate at the Bay Area Maker Faire on May 20-21.

Fig. 1 CCC Maker Implementation Plan Focus Areas

MAKERSPACE START-UP ACTIVITIES

The CCC Maker start-up process emulated traditional business startup activities in many ways. Tools were used to conduct ecosystem mapping [Fig 2], a self-study and background research, logic modeling, and experimental student maker activities. Work was supported and shared using webinars, video conferencing, regional meet-ups, blog posts, electronic newsletters, project updates, professional training sessions, makerspace tours and one-on-one consulting with technical assistance providers. Specialized Service Providers such as Maker Ed, Kiva, Hacker Lab, the National Association for Community College Entrepreneurship, the California Council on Science and Technology, Making Across the Curriculum and New World of Work, enriched the planning process through consultation and professional development. Startup principles and fundamentals included:

1. **A thorough understanding of the environment in which each makerspace would exist.** Each self-assessment study asked, "What kinds of students (customers) might be attracted to makerspace programs? What do the student demographics show? What are the existing connections with the business community, funders, and the internal community college infrastructure? What problems must be addressed for each makerspace solution?" This process of inquiry led to frequent breakthroughs, much like a startup seeking understanding of a new business with background research. For instance, *Sierra College* student Sebastian Romanet, Mechatronics major, lead a research effort to gather input from students and faculty who are members of Hacker Lab powered by Sierra College. The goal was to gather insights that could be incorporated in the Sierra College system-wide makerspace plan covering three campuses in Rocklin, Grass Valley and Tahoe Truckee. "I wanted to lead the research effort to ensure that the student voice was heard by faculty and the appropriate college bodies; allowing me to do my part in ensuring that the same opportunity that was here for me is here for many more students to come. Public/private relationships between colleges and makerspaces are an incredible opportunity, and I want to make sure that the students who need them and want to take advantage of them have access to the same networking and learning opportunities that I have had." Romanet presented preliminary results at a team meeting so others could incorporate the information into their work.

The use of design-thinking exercises to consider problem-solution pairs, much like a startup business that seeks to find their unique position in the marketplace. This activity was intended to stretch the preconceived vision of the makerspace into better and perhaps unexpected solution ideas, resulting in a chance to meet needs unique to a college's community and environment. For example, *Cabrillo College* partnered with the Economic Development Manager for the City of Santa Cruz to identify an ecosystem of innovative designers, makers, fabricators, and entrepreneurs across Santa Cruz County in the development of a larger, more accessible, and more impactful makerspace for the Monterey Bay area. Over 180 potential makerspace stakeholders and beneficiaries in the community were invited to participate in a fun, collaborative, all-day Makerspace Plan-a-thon in April 2017 to
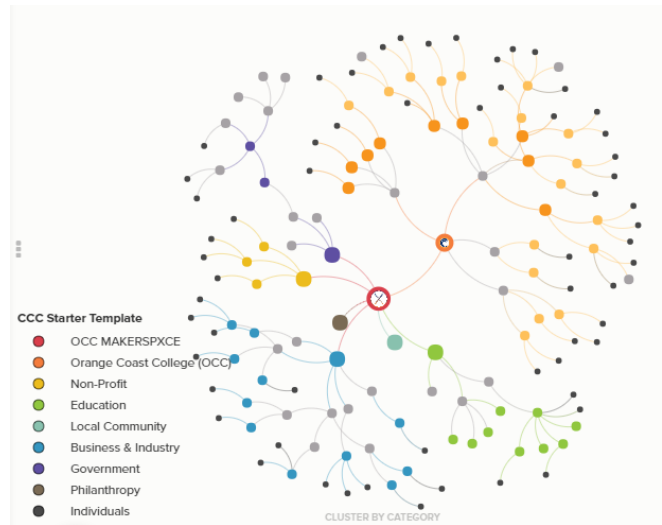

Fig. 2 An example of an Ecosystem Map for Orange Coast College

discuss makerspace equipment, classes, skills and techniques, hardware, software and materials training needed for future workers, accessibility needed to create NextGen entrepreneurs, and matching students to quality internship programs. Another example included *Allan Hancock College* which partnered with the Santa Maria Valley Discovery Museum and the Santa Maria Public Library to bring makerspaces to the Santa Maria Valley. "We talk a lot in education about training people specifically for one job," says Bob Mabry machining and manufacturing instructor. "What kind of skills will people need to succeed no matter where they end up? This is about collaboration, communication, critical thinking and problem solving -- creatively. (Makerspaces) are a vehicle for all of that."

2. **Sage advisors.** The CCC Maker advisory board guided the initiative's direction, made important connections, and provided encouragement. For example, the advisory board demonstrated several approaches that could be used by the community college teams to reach and motivate area businesses to partner with the makerspaces. Paraphrasing the advisor's recommendation: "The makerspace coordinators need to really listen and see how they might focus their narrative to the business' interests. Keep in mind these organizations need to see value of some kind in these partnerships. It doesn't always need to be a financial benefit, but the makerspace team needs to explore win-win opportunities like access to trained employees, or perhaps to keep the business in tune to technology changes that may be useful in the future."

3. **A focus on the startup team and their skillsets as a fundamental startup strategy.** Each site worked on their organization and roles of their makerspace team. Supporting and providing training opportunities lead to stronger, more resilient teams. For example, at *Folsom Lake College's* Innovation Center, the student voice is critical in the development of makerspace programs, services, and culture. In May 2017, a dedicated and engaged group of students held a planning retreat to guide development of the makerspace. After some general discussion about planning mechanics – students agreed to continue using Slack (for team communi-

cation), Google Drive (for document sharing), and Asana (for project and task management) as the planning and communication toolset. On the Slack Operations thread, discussions focused on the onboarding of new students, and facility and machine access issues, safety and training, facility usage tracking, and protocols around equipment upkeep, maintenance, and supplies. On the Marketing and Outreach threads, the team discussed the development of an Innovation Center Makerspace brand, including logo, typography, colors and a style guide, and an outreach plan, the potential for a "makerspace student ambassador" program, classroom presentations, involvement of student clubs and organizations, and activities leading up to a grand opening event in the fall. Finally, the group did some brainstorming around the theme of Makerspace Programming, and generated ideas including hosting coding and other bootcamps, eSports tournaments, mini Maker Faire participation, 1st Friday "What I Make" sessions, the proposed Makers in Residence program, and integration with Science Center and other college-wide activities.

4. **Opening or adding additional services as a dynamic activity.** Planning set the groundwork, but the emphasis was on action. The advisory board's inspired philosophy of "try it and see what might go right" was paired with Steve Blank's startup advice to 'fail fast' and pivot. Colleges were encouraged to be creative and try different approaches, creating a philosophy that embraces failure as a natural part of the process. For example, 41 *Sacramento City College* students formed four working groups to construct a giant inflatable brain with integrated electronic components. Using a 1/8 scale mockup, students launched a Go Fund Me campaign to help pay for project supplies. Faculty across multiple departments were used as a resource, but as a student-designed and managed project, both success and failures were theirs alone. The final project, with a 9-foot by 4-foot base, was exhibited at the Bay Area Makers Faire, Sacramento's 2nd Saturday Art Walk, and at the State Capital. Students also created blog posts and a documentary as part of their makerspace planning efforts [2] and designed posters [Fig. 3] as part of a mass media campaign. Another example was *Orange Coast College*, which shifted from a faculty centered to a student centered model, completely transforming the concept for the makerspace from narrowly focused on one academic discipline to an interdisciplinary space [Fig. 4] based on a reinterpretation of the principles of the Bauhaus. This expanded scope occurred in numerous colleges, suggesting that leading with community first broadens the sense of possibility.

5. **Locating and leveraging resources in order to take concepts to scale.** Community colleges are accustomed to being 'scrappy' and cobbling a variety of resources together to develop services and programs that meet customer (student) needs. The $40,000 Seed Grants were leveraged more than nine times over as colleges identified additional resources to help implement their makerspace plans. Networking and

Fig. 3 Sacramento City College Student Designed Posters

collaboration with other colleges, businesses, nonprofits, and mapping the makerspace ecosystem also formed a robust support system of like-minded partners and leaders.

By May 2017, twenty-eight colleges had produced implementation plans with proposed strategies, detailed work plans and budgets that addressed four key outcomes: Community of Practice, Curriculum, Internships and Makerspace development. Colleges presented their plans to an audience of peers and advisors at a culminating celebration at *San Mateo College*. Their unique plans documented more than 2,700 ecosystem partners, 1,000+ student and community activities participants, 200+ engaged faculty, 50+ administrators and 100+ student team members, proposed 1,400 student internships and leveraged more than $10m in matched resources. Teams then shared their plans with the thousands of people attending the Bay Area Maker Faire on May 20-21 at a CCC Maker booth. Student work included *Sierra College's* laser cut mandala that engaged both children and adults. *Sacramento City College* students brought the inflatable brain. *Cabrillo College* and *Laney College* had their own dedicated booths staffed with faculty and students.

Through mid-June 2017, technical assistance continued to help colleges improve their plans for consideration of additional grant funding. The Technical Assistance Provider scheduled 'office hours' using phone or video conferencing. Additional webinars were recorded on topics such as budgets and workplans. The final proposal submissions included both traditional narrative elements and portfolio documents such as video and photo documentation, diagrams (from formative hand-drawn sketches to graphically complex logic models), ecosystem maps, blog posts and letters of support from community and college partners. In July 2017, a team of independent readers awarded nearly $6,000,000 to 24 colleges with inclusive, interdisciplinary, collaborative and student-centered plans with a forward thinking sense. Colleges successfully completing their workplan will be eligible for an additional funding for 2018-2019.

LESSONS LEARNED

1. **Focusing on makerspace community building before planning the physical space intentionally supported a new culture of 'problem-finding'** vs. solutions-based thinking, and mobilized ecosystem partners around a new identity and sense of pride for each college's makerspace initiative. By sharing their plans with their peers in a collaborative, supportive environment, teams were then able to reflect on the differences between college needs and resources and how they resulted in different solutions. Alternative, flexible approaches were encouraged and allowed colleges to see the uniqueness of their own response to the design problem. This was empowering as each college had taken constraints and problems and reframed them as opportunities upon which to build solutions.

2. **The Startup process for the CCC Maker initiative allowed colleges to experiment in new ways**. For educators with an entrepreneurial mindset, the process was cherished and celebrated. The project team message, "We're all in this together" fostered community and a safe place for risk, failure and iteration consistent with the Maker Movement. Using Kumu (kumu.io) to map ecosystem partners added to a body of knowledge developed by the National Association for Community College Entrepreneurship. Internal collaboration and external competition within a limited time frame accelerated college experimentation, resulting in unique, unexpected ideas and proposals. Flexible guidelines permitted colleges to submit plan components and receive feedback up until the final deadline. Colleges already engaged in the Maker Movement gained validation, allowing them to move deeper into innovative plans and practices. What may have been considered a 'fringe' educational practice began to be seen as prescient educational innovation.

3. **The process of acting nimble and adaptive during the planning phase was a challenge for many colleges**. The top down, locally focused organizational structure of the community college system was at odds with the self-organizing, self-replicating, open source network of the Maker Movement. Dynamic, non-traditional teams led by enthusiastic but inexperienced faculty sometimes experienced disconnection with administration. There were power struggles within the educational hierarchy, executive leadership that was sometimes missing, team leads who focused on a single academic discipline, and student voices that were missing. Some colleges with existing makerspaces resisted further innovation and collaboration. The flexible, self-paced process challenged some teams to meet mileposts and deadlines.

4. **Developing inclusive teams (e.g. faculty from multiple disciplines, students, businesses and community stakeholders) was hard work but had high returns.** Colleges that had diverse partnership structures, such as a museum, library, a private makerspace partner, cross-disciplinary faculty and students, created more ideas and prototypes during the planning process and leveraged more resources than
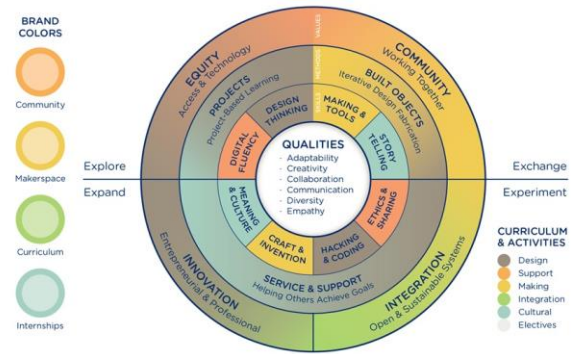

Fig. 4 Orange Coast College Bauhaus-inspired diagram

colleges with simpler or less-diverse partnerships. Colleges with strong student and faculty leaders produced plans and experimented with prototypes that were more closely aligned with what Mark Hatch calls "The Maker Manifesto" principles of Make, Share, Give, Learn, Tool Up, Play, Participate, Support, Change.[3] This experience matches findings from other bodies of work including an analysis by Katherine Phillips, from numerous research studies, that, "Diversity enhances creativity. It encourages the search for novel information and perspectives, leading to better decision making and problem solving;" and a field study of 92 workgroups by Jehn, Northcraft and Neale which found that informational and social category diversity positively influence group performance. [4] [5]

5. **Extending inclusivity to other CCC Maker colleges initiated a Community of Practice**. The community of practice that emerged has been strongly endorsed by colleges. In a July 2017 survey, respondents described a sense of camaraderie, the perception that their regional partners were increasingly aware of, and ready to collaborate with each other moving forward. Some colleges struck up agreements to coordinate on specific outcomes of the project including internships, badging, curriculum development and makerspace design. This was particularly valuable as colleges moved into the competitive phase of the project and now had an idea of the competitive field in which they were working.

6. **Student leaders were simply amazing**. From developing and implementing surveys to holding makerspace events, to building collaborative projects, to conducting on-campus marketing campaigns, students energized teams and demonstrated through active experimentation that makerspace communities were a natural fit to the community college environment. Student leaders often worked independently, using faculty as a resource but not as a decision-maker, and used their experiences to demonstrate 'what could go right' with their campus makerspace community. This experience matches findings from other bodies of work including a research study by Tamera Thies at the University of Iowa where student leaders served as educational change agents resulting

in improved curriculum, performance and class attrition rates; and examples from a working paper by Mick Healey, Emeritus Professor University of Gloucestershire; Adjunct Professor Macquarie University, showing impact from students engaged as educational change agents. [6] [7]

7. **Resource constraints were a competitive advantage, encouraging 'bootstrapping' and other creative methodologies**. The collaborative/competitive model generated an enormous amount of ideas, engagement, community building and information, making the $40,000 Seed Grant funding a highly effective use of a relatively small sum. Colleges produced volumes of quality work, adding to the body of knowledge now available to all. This was far above what could have been provided through a traditional Technical Assistance Provider and Project Team model design.

SPECIAL AREAS OF EMPHASIS IN YEARS TWO & THREE: STUDENTS, CULTURE AND LEADERSHIP

CCC Maker colleges conducting projects over the next two years will be taking their planning efforts to scale, experimenting and iterating on integrated curriculum, work-based experiences, open source learning environments, and expansive ecosystems of connected partners and stakeholders.

It is our hypothesis that CCC Maker colleges will have a higher degree of impact and sustainability if three operational goals are adopted and institutionalized:

1. College makerspaces are student-focused, inclusive and engage students through open exploration, customized skill development; and provide students opportunities to make an impact on their lives and the lives of others. Examples might be makerspace-related competitions, class projects or student clubs with a social justice theme or a goal of improving the human condition.

2. Colleges embrace and adopt the makerspace culture beyond the confines of the makerspace. Examples might be cross-disciplinary faculty collaboration to integrate making into curriculum; students serving as mentors for faculty learning new technologies or software; digital badges awarded for micro-credentials including New World of Work 21st century skills [Fig.5]; and startup businesses that are encouraged, supported and even celebrated.

3. Colleges develop and implement student leadership programs related to makerspace operations. Examples might be students serving as makerspace teachers, students selected as specialized 'agents of change' in the makerspace and on campus, and students developing safety protocols and procedures for machinery in the makerspace.

CCC Maker colleges will receive technical assistance and support to a) incorporate these goals into their annual workplans, and b) develop related strategies and activities to implement in years two and three of the project. Metrics will include number of students prepared for and completing internships, engaged in the makerspace, completing specialized training and certifications earned; number of faculty engaged in the makerspace and completing specialized training; the number and type of ecosystem partners; new curriculum; and qualitative data including student success stories.

You've demonstrated that you can consider multiple points of view, recognize problems and needs in society or the workplace, examine information broadly, and develop multiple solutions to those problems. Great job!

Fig. 5 New World of Work 21st century skills digital badge

CONCLUSION

The CCC Maker initiative is building a statewide network of community college makerspaces that are integrated into academic environments.   In Year One of the initiative, 34 community colleges participated in an accelerated Start-Up process. Twenty-eight colleges submitted implementation plans, and 24 colleges were selected in July 2017 to receive nearly $6 million in supportive funding. Colleges successfully completing scopes of work will be eligible for additional funding for 2018-2019. Expected benefits are that students will become skilled leaders and innovation-ready graduates; faculty will engage in interdisciplinary collaboration and develop new curriculum, skills badges and micro-certificates responsive to workforce needs; and community colleges will become nimble and adaptive regional assets that positively affect workforce performance and economic growth. CCC Maker colleges will implement workplans in year two to build a community of practice, provide work-based experiences for students, develop innovative curriculum, and provide an accessible makerspace environment. An additional focus will be on student leader development, makerspace culture, and inclusivity and student-engagement.

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